

# Multilevel Analysis: Villages do not have Ecological Effect on the Risk of Diabetes Mellitus Type 2 in Surakarta, Central Java

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## ABSTRACT

**Background:** Diabetes Melitus (DM) as The Silent Killer has an increasing number of cases. Type 2 diabetes and its complications are a major public health problem worldwide. Type 2 diabetes is influenced by various factors. This study aimed to analyze the contextual effect of village on the risk of type 2 DM.

**Subjects and Method:** This was a case-control study conducted in Surakarta, from November 2019 to January 2020. A sample of 200 patients type 2 DM and non-DM was selected by fixed disease sampling. The dependent variable was type 2 DM. The independent variables were family history of DM, diet, physical activity, Body Mass Index (BMI), central obesity, stress, history of hypertension, and smoking habit. The data were collected by questionnaire and analyzed by a multilevel multiple logistic regression run on Stata 13.

**Results:** The risk of type 2 DM was positively associated with family history of diabetes ( $b = 2.37$ ; 95% CI = 1.51 to 3.23;  $p < 0.001$ ), poor diet ( $b = 1.09$ ; 95% CI = 0.71 to 1.86;  $p = 0.034$ ), low

physical activity ( $b = 1.07$ ; 95% CI = 0.12 to 2.02;  $p = 0.027$ ), central obesity ( $b = 1.01$ ; 95% CI = 0.75 to 1.95;  $p = 0.034$ ), stress ( $b = 1.07$ ; 95% CI = 0.15 to 1.98;  $p = 0.022$ ), history of hypertension ( $b = 1.08$ ; 95% CI = 0.19 to 1.96;  $p = 0.016$ ), and smoking habit ( $b = 1.31$ ; 95% CI = 0.22 to 2.39;  $p = 0.018$ ). Village did not have a contextual effect on the risk of type 2 DM with ICC = 0.01%.

**Conclusion:** The risk of type 2 DM is positively associated with family history of DM, diet, low physical activity, central obesity, stress, history of hypertension, and smoking habit. Village do not have a contextual effect on the risk of type 2 DM.

**Keywords:** type 2 diabetes mellitus, biopsychosocial, multilevel analysis

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## BACKGROUND

Diabetes Melitus (DM) as The Silent Killer has an increasing number of cases. In 2015, 214 million people in the world experienced DM. The number of sufferers increased from 2002 which was only 177 million people. The International Diabetes Federation (IDF) predicts that patients with diabetes mellitus will increase in 2040 to 642 million sufferers (IDF, 2015). Basic Health Research Results Data (2018) shows the prevalence of diabetes

in Indonesia in 2018 of 2.0%. This figure is higher than the prevalence in 2013 (1.5%). Central Java Province is in the 12th rank with an increase in prevalence of 1.6% in 2013 to 2.1% in 2018 (Ministry of Health, 2018).

Data from the Surakarta City Health Office reported that the number of people with type 2 DM was quite large, in 2017 there were 29,041 people (7.13%), and in 2018 there were 26,887 people (6.59%) (Surakarta Health Office, 2018). Despite the decrease in

the number of sufferers, it is still necessary to control non-communicable diseases to find out the risk factors that influence the incidence of type 2 diabetes.

Type 2 DM is influenced by various factors. Based on a study by Murad et al. (2014), family history of DM (OR = 3.75;  $p = 0.020$ ) is associated with the incidence of type 2 DM.

Someone who has a family history of DM is 3.75 times more likely to experience the incidence of type 2 diabetes. Unbalanced dietary patterns are also a risk factor for type 2 DM. A study by Tjekyan (2014), reported that poor eating patterns such as frequent consumption of coffee, fatty foods and junk food ( $p = 0.026$ ) associated with the incidence of type 2 diabetes. This was not in line with Chandra and Restuastuti (2007), who stated that dietary risk factors ( $p = 0.896$ ) were not related to the incidence of type 2 DM.

A study by Budiarti et al. (2016) stated that someone who did physical activity tends to have a normal BMI, BMI (OR = 2.66;  $p = 0.001$ ) has a significant relationship with the incidence of type 2 DM. Doing exercises such as jogging, gymnastics, or playing basketball becomes one form of physical activity that can be routinely carried out to control blood sugar levels (Caballero, 2018).

Other risk factors such as stress, history of hypertension, and smoking habits can influence the incidence of type 2 diabetes. Murad et al. (2014) stated that a person who is experiencing stress and depression tends to have poor blood glucose levels, which caused insulin resistance. Someone who is depressed has 1.03 times of risk in developing DM type 2 ( $p = 0.001$ ).

Someone who has a history of hypertension is 3.58 times more likely to have type 2 DM compared to someone who has no history of hypertension and someone who has a smoking habit is 3.97 times more likely to have type 2 DM.

Therefore, the authors are interested in

conducting a study toward the contextual effect of village on the risk of type 2 DM.

## SUBJECTS AND METHOD

### 1. Study Design

This was a case control study conducted in Surakarta, Central Java, Indonesia, from November 2019 to January 2020.

### 2. Population dan Sample

The source population used in this study was DM type 2 sufferers in Surakarta. The number of samples was 200 study subjects consisting of 50 type 2 DM patients and 150 without type 2 DM. They were selected by fixed disease sampling.

### 3. Study Variables

The dependent variable was type 2 DM. The independent variables were family history of DM, diet, physical activity, Body Mass Index (BMI), central obesity, stress, history of hypertension, and smoking habits. Village was variables in level 2.

### 4. Operational Definition of Variables

**Type 2 DM** occurred when it has been diagnosed by a doctor who is supported by laboratory results. The measurement scale was categorical.

**Family history of DM** was the presence of a family with DM who is one lineage with study subjects. The measurement scale was categorical.

**Dietary pattern** was a method of consumption and type of food that is carried out by study subjects in their daily eating activities that can cause DM type 2 diseases such as high calories, carbohydrates, fat, protein, sugar, and salt. The measurement scale was continuous, but it was transformed into dichotomous.

**Physical activity** was a study subject habit in exercising and doing daily activities both at home and while working. Physical activity is measured based on the activities that are often carried out by study subjects, then calculated the total value of the Metabolic

Equivalent Task (MET) overall of the activities carried out. The measurement scale was continuous, but it was transformed into dichotomous.

**BMI** was the body mass index as body weight in kilograms (kg) divided by height in meters squared ( $m^2$ ) calculated before the study subjects are exposed to type 2 diabetes mellitus. The measurement scale was continuous, but it was transformed into dichotomous.

**Central obesity** was the accumulation of fat in the body of the abdomen, usually the measurement of the circumference of the stomach is used to determine whether someone is obese or not. The measurement scale was continuous, but it was transformed into dichotomous.

**Stress** was a condition of feeling experienced when someone considers that demand exceed the social and personal resources that can be done by someone. The measurement scale was continuous, but it was transformed into dichotomous.

**History of hypertension** was someone who has a history of hypertension that has blood pressure  $\geq 140/90$  mmHg. The measurement scale was categorical.

**Smoking habit** was the number of cigarettes smoked in one day. The measurement scale was continuous, but it was transformed into dichotomous.

## 5. Study Instruments

The study instrument used for data collection

**Table 1. Sample Characteristics (Continuous Data)**

Variable	n	Mean	SD	Min.	Max.
Age (years old)	200	53.5	9.5	24	77
Income (rupiah)	200	1,233,700	1,770,871	0	17,000,000
Dietary pattern	200	15.48	4.8	4	28
Physical activity	200	7,117.1	7,230.9	57	35,007
BMI ( $kgBW/m^2$ )	200	24.3	4.5	14.2	39
Abdominal circumference (cm)	200	89.1	13.6	52	195
Stress	200	7.5	5.6	0	26
Systolic (mm/Hg)	200	120.2	13.9	80	170
Diastolic (mm/Hg)	200	86.3	10.1	50	130

was a questionnaire that had been tested for validity and reliability. The questionnaire was used to measure data on family history of DM, diet, physical activity, BMI, central obesity, stress, history of hypertension, and smoking habits. Metline measurement tool to measure central obesity data.

## 6. Data Analysis

Univariate analysis used to see the frequency distribution and percentage characteristics of study subjects. Bivariate analysis used to study the relationship between DMtype 2 with independent variables by using the chi-square test. Multivariate analysis was using logistic regression analysis through a multi-level approach with the Stata 13 program to determine the effect of village contextual on biopsychosocial determinants of type 2 DM incident.

## 7. Research Ethics

Ethical clearance in this study was obtained from the Health Research Ethics Commission of Moewardi Hospital Surakarta City with the number of 1.288/XII/HREC/2019 published on December 3, 2019.

# RESULTS

## A. Sample Characteristics

The characteristics of this study include age, gender, education, occupation, and income. These characteristics can be shown in Tables 1 and 2.

**Table 2. Sample Characteristics (Dichotomous Data)**

Sample Characteristics		n	%
<b>Age (years old)</b>	<46 years old	39	19.50
	≥46 years old	161	80.50
<b>Gender</b>	Female	80	40.00
	Male	120	60.00
<b>Education</b>	No School	31	15.50
	Elementary school	59	29.50
	Junior high school	36	18.00
	Senior high school	56	28.00
<b>Employment</b>	College	18	9.00
	Civil Servant/SOE	5	2.50
	Private employees	12	6.00
	Entrepreneur	56	28.00
	Housewives	63	31.50
	Labor	30	15.00
	Others	34	17.00
<b>Income (Rupiah)</b>	<Rp 1,802,700	143	71.50
	≥Rp 1,802,700	57	28.50
<b>Village Category</b>	<i>Pratama</i>	3	12.00
	<i>Madya</i>	3	12.00
	<i>Purnama</i>	3	12.00
	<i>Mandiri</i>	16	64.00

**Table 3. Bivariate Analysis**

Independent Variable	Type 2 DM				Total		OR	p
	No		Yes		n	%		
	n	%	n	%				
<b>Family History of DM</b>								
None	120	88.9	15	11.1	135	100	9.33	<0.001
Yes	30	46.2	35	53.8	35	100		
<b>Diet</b>								
Good	68	80.9	16	19.1	84	100	1.76	0.009
Poor	82	70.7	34	29.3	116	100		
<b>Physical Activity</b>								
High	127	80.4	31	19.6	158	100	3.38	<0.001
Low	23	54.8	19	45.2	42	100		
<b>BMI</b>								
Normal	97	77.6	28	22.4	125	100	1.44	0.273
Overweight/Obesity	53	70.7	22	29.3	75	100		
<b>Central Obesity</b>								
Normal	60	83.3	12	16.7	72	100	2.11	0.040
Obesity	90	70.3	38	29.7	128	100		
<b>Stress</b>								
Normal	124	81.1	29	18.9	153	100	3.45	<0.001
Stress	16	55.3	21	44.7	47	100		
<b>History of Hypertension</b>								
None	114	80.9	27	19.1	141	100	2.69	0.003
Yes	36	61.0	23	39.0	59	100		
<b>Smoking</b>								
No	134	79.3	35	20.7	169	100	3.59	<0.001
Yes	16	51.6	15	48.4	31	100		

**B. The result of bivariate analysis**

The analytical test used in the bivariate analysis is the chi square test. Bivariate analysis

based on the results of this study can be seen in Table 3.

**Table 4. A Multiple Multilevel Logistic Regression Analysis of Ecological Effect of Villages on the Risk of Type 2 DM**

Independent Variable	Regression Coefficient (b)	95% CI		p
		Lower Limit	Upper Limit	
Fixed Effect				
Family history of DM (Yes)	2.37	1.51	3.23	<0.001
Dietary Pattern (Poor)	1.09	0.71	1.86	0.034
Physical Activity (Low )	1.07	0.12	2.02	0.027
Central Obesity (Obesity)	1.01	0.75	1.95	0.034
Stress (Experience Stress)	1.07	0.15	1.98	0.022
History of Hypertension (Yes)	1.08	0.19	1.96	0.016
Smoking Habit (Yes)	1.31	0.22	2.39	0.018
Constants	-4.60	-6.03	-3.18	<0.001
Random Effect				
Var (Constants)	<0.001			
n observation= 200				
n group= 25				
Log Likelihood= -74.776022				
Group Average= 8				
Min= 8, max= 8				
p= <0.001				
ICC= 0.01%				

**C. The result of multilevel analysis**

Multiple logistic regression analysis with a multilevel approach described the effect of more than one independent variable (family history of DM, dietary patterns, physical activity, central obesity, stress, history of hypertension and smoking habits) on the dependent variable (incidence of type 2 DM). The following results of multivariate analysis of the incidence of type 2 DM by using multiple logistic regression with a multilevel approach can be seen from Table 4.

Table 4 showed that there was an influence of family history of DM on the incidence of type 2 diabetes. Someone with a family history of DM has a possibility (logodd) to experience type 2 diabetes by 2.37 units greater than someone who has no family history of DM (b=2.37; CI 95%= 1.51 to 3.23; p<0.001).

There was an influence of diet on the

incidence of type 2 diabetes. A person with poor diet has the possibility (logodd) to experience type 2 diabetes by 1.09 units greater than someone with a good diet (b=1.09; CI 95%= 0.71 to 1.86; p= 0.034).

There was an influence of physical activity on the occurrence of type 2 diabetes. Someone with low physical activity has a possibility (logodd) to experience DM type 2 by 1.07 units greater than someone who has good physical activity (b=1.07; CI 95%= 0.12 to 2.02; p= 0.027).

There was an effect of central obesity on the incidence of type 2 diabetes. Someone who has central obesity has a possibility (logodd) to experience type 2 diabetes by 1.07 units greater than someone who did not experience central obesity (b=1.01; CI 95%= 0.75 to 1.95; p= 0.034).

There was an effect of stress on the incidence of type 2 diabetes. Someone who was



stressed has a possibility (logodd) to experience type 2 diabetes by 1.07 units greater than someone who was not experiencing stress ( $b=1.07$ ; CI 95%= 0.15 to 1.98;  $p=0.022$ ).

There was an effect of history of hypertension on the incidence of type 2 diabetes. Someone who has a history of hypertension has a possibility (logodd) to experience type 2 diabetes by 1.08 units greater than someone who did not have a history of hypertension. ( $b=1.08$ ; CI 95%= 0.19 to 1.96;  $p=0.016$ ).

There was an effect of smoking on the incidence of type 2 diabetes. Someone who smoke has a logodd chance to experience type 2 diabetes by 1.31 units greater than someone who did not smoke ( $b=1.31$ ; CI 95%= 0.22 to 2.39;  $p=0.018$ ).

There was no contextual influence of village on the variation in type 2 DM incident (ICC = 0.01%). That was because most of the villages have the same characteristics which were included in the category of active active standby villages with a total of 16 villages (64%).

## DISCUSSION

### 1. The Effect of Family History of DM on the Risk of Type 2 DM

The results of this study indicated that there was an influence between family history of DM on the incidence of type 2 DM.

Genetic factors directly affect beta cells and change their ability to recognize and spread insulin secretory stimuli. These conditions increase the risk of a person experiencing changes in the integrity and function of pancreatic beta cells. Genetically, the risk of type 2 DM increased in monozygotic twins, mothers of neonatus who were more than 4 kg, or individuals with the obesity gene (Damayanti, 2015).

Maharana et al. (2019) showed that there was a significant influence between family history of DM and the incidence of

type 2 DM ( $p=0.007$ ). A person who has a family history of DM was 9.8 times more likely to have type 2 diabetes compared to someone who has no family history of DM. A study by Budiarti et al. (2016), stated that there was a relationship between family history of DM and the incidence of type 2 DM ( $p<0.001$ ). Someone who has a family history of DM such as mother, father, or sister, and younger sibling was 2.56 times more likely to have type 2 diabetes than someone who has no family history of DM.

### 2. The Effect of Dietary Pattern on the Risk of Type 2 DM

The results of this study indicated that there was an influence between dietary patterns on the incidence of type 2 diabetes.

Insulin deficiency that occurred in patients with type 2 diabetes caused not all glucose can be converted into glycogen, so glucose from food stays in the blood (hyperglycemia), high levels of glucose in the blood caused by decreased ability of the body to convert glucose into glycogen. The occurrence of gluconeogenesis in the liver (the process of converting liver glycogen into glucose due to the majority of glucose coming out with urine) caused the formation of glucose and into the bloodstream. The results showed that there was a relationship between dietary pattern and the incidence of type 2 diabetes ( $p=0.020$ ) (Hariawan et al., 2019).

This study was in line with Fearch et al. (2019), which stated that someone who consumed foods high in salt, fat and sugar has a risk of developing type 2 diabetes, which was 1.51 times higher compared to someone who did not consume foods which high in salt, fat and sugar (OR= 1.51; CI 95%= 1.61 to 1.93;  $p=0.003$ ).

This study was consistent with Sadiya and Mnla (2019) which stated that someone who has a good diet such as eating fast food less 1-2 times a week, was able to prevent the incidence of type 2 DM by 1.83 times

compared to someone who often consumed fast food for >3 times a week (OR= 1.83; CI 95%= 1.02 to 3.3; p= 0.040).

### **3. The Effect of Physical Activity on the Risk of Type 2 DM**

The results of this study indicated that there was an effect of physical activity on the incidence of type 2 DM.

Exercise or physical activity is very important, physical activity improves insulin resistance so insulin becomes more effective in transporting glucose. Physical activity burns calories in muscle as glucagon and the need to replace the burned calories make the glucose out of the bloodstream, so that it can reduce circulating sugar. Physical activity also helps people to lose and maintain weight to avoid obesity, because obesity is one of the triggers for type 2 diabetes (Brayer-Ash, 2012).

This study was consistent with Mota-med et al. (2019), which stated that someone who has low physical activity (<METS) was 2.06 times at risk of developing type 2 DM compared to someone who has high physical activity. Other studies have shown that someone who was  $\geq 45$  years old and having low physical activity was 1.24 times more likely to develop type 2 diabetes than someone who was <45 years old and has high physical activity (OR= 1.24; 95% CI= 1.09 to 1.56; p= 0.006) (Chireh and Arcy, 2019). Based on some of the statements above, it can be concluded that physical activity affected the incidence of type 2 diabetes.

### **4. The Effect of Central Obesity on the Risk of Type 2 DM**

The results of this study indicated that there was an effect between central obesity on the incidence of type 2 diabetes.

Tchernof and Després (2013) defined central obesity as a buildup of fat in the abdomen. This accumulation of fat is caused by excess fat in the subcutaneous fat tissue and abdominal visceral fat. The accumulation

of fat in visceral fat tissue is a form of non-functioning subcutaneous fat tissue in the face of excess energy due to excessive fat consumption. The inability of subcutaneous fat tissue as a buffer for excess energy will cause the production of fat that can accumulate in unwanted body parts, such as the liver, heart, kidneys, muscles, and pancreas glands. Central obesity is measured through the circumference of the stomach, for men no more than 90 cm, and for women no more than 80 cm (Ministry of Health, 2018).

This study was supported by Pratiwi et al. (2018), which stated that a person with central obesity was 2.93 times at risk of developing type 2 diabetes because in central obesity, fat accumulated around the middle abdomen is associated with insulin resistance and diabetes (OR=2.93; CI 95%=1.29 to 6.65; p=0.009).

This study was consistent with Chireh and Arcy (2019), which stated that there was an influence between central obesity and the incidence of type 2 diabetes. People who have central obesity were 3.24 times more likely to develop type 2 diabetes compared to someone who has a normal size of abdominal circumference (OR= 3.24; CI 95%= 2.39 to 4.41; p<0.001).

### **5. The Effect of Stress on the Risk of Type 2 DM**

The results of this study indicated that there was an influence of stress on the incidence of type 2 DM.

Stress is a non-specific demand that requires someone to respond or take action. Patients with type 2 diabetes who are experiencing stress can change their diet, exercise, use of drugs that are usually obeyed and this can cause hyperglycemia. Stress triggers the body's biochemical reaction, the first reaction of the stress response is the secretion of the sympathetic nervous system which causes an increase in heart frequency. This causes blood glucose to rise, if stress persists,

it will cause the hypothalamus-pituitary which triggers an increase in cortisol so that it affects an increase in blood glucose through catabolism of proteins and fats, and inhibits glucose uptake by body cells. The results showed that there was a relationship between stress and the incidence of type 2 diabetes. Someone who was stressed had a risk of 3,030 times of suffering from type 2 diabetes compared to someone who did not experience stress (OR=3.03; CI 95%=1.18 to 7.82;  $p=0.036$ ) (Kabosu et al., 2019).

This study was supported by Ogihara et al. (2017), which stated that stress affected the incidence of type 2 diabetes. A person who was experiencing stress was 2.39 times at risk of developing type 2 diabetes compared with someone who was not stressed (OR= 2.39; 95% CI= 1.01 to 2.47;  $p= 0.017$ ). Other study also stated that there was an effect between stress and the incidence of type 2 diabetes. Someone who was stressed has a possibility (logodd) to experience type 2 diabetes by 1.03 units greater than someone who was not stressed ( $b=1.03$ ; CI 95%=0.42 to 1.63;  $p<0.001$ ) (Budiarti et al., 2016).

#### **6. The Effect of History of Hypertension on the Risk of Type 2 DM**

The results of this study indicated that there was an influence between the history of hypertension on the incidence of type 2 diabetes.

Hypertension is one of the triggers for type 2 diabetes. Hypertension that is not managed properly in patients with type 2 diabetes will cause disease complications by accelerating damage to the kidneys and cardiovascular abnormalities. Many factors can affect the increase in blood pressure, in people with type 2 diabetes are insulin resistance, plasma blood pressure, and obesity (Damayanti, 2015).

This study was in line with Rahman et al. (2019), which showed that there was an influence on the history of hypertension with

the incidence of type 2 DM ( $p= 0.080$ ). This was supported by Akhtar and Dhillon (2017), which stated that there was a relationship between hypertension and the incidence of type 2 diabetes. A person suffering from hypertension was at risk of experiencing a type 2 diabetes by 1.6 times compared to someone who was not hypertension (OR=1.6; CI 95%=1.56 to 1.63;  $p<0.001$ ).

This study was consistent with Shen et al. (2019), which stated that there was a relationship between the history of hypertension and the incidence of type 2 diabetes. Someone who has a history of hypertension has a risk of 2.09 times to have type 2 diabetes compared to someone who has normal blood pressure (OR = 2.09; 95% CI = 2.0 to 3.3;  $p= 0.012$ ). Other study also stated that there was a relationship between the history of hypertension and the incidence of type 2 DM ( $p<0.001$ ) (Agrawal et al., 2019). Based on some of the statements above, it can be concluded that the history of hypertension affected the incidence of type 2 diabetes.

#### **7. The Effect of Smoking Habit on the Risk of Type 2 DM**

The results of this study indicated that there was an effect of smoking habit on the incidence of type 2 diabetes.

Based on a study by Priyambodo and Wuryaningsih (2017), smoking habit is carried out by diabetics who are male. Nicotine contained in cigarette smoke has an influence on the occurrence of type 2 diabetes. The effect of nicotine on insulin causes a decrease in insulin release due to the activation of the catecholamine hormone, a negative effect on insulin action, disruption in pancreatic beta cells and progression towards insulin resistance. Smoking can also cause hypertension, which is a risk factor for type 2 diabetes.

This study was in line with Agrawal et al., (2019), which stated that there was a relationship between smoking habits and the



incidence of type 2 diabetes ( $p < 0.001$ ). This was supported by Sukmaningsih (2016), which stated that there was a relationship between smoking habits with the incidence of type 2 diabetes, where someone who has a smoking behavior was 2.54 times more likely to suffer from type 2 diabetes compared to someone who did not smoke ( $OR=2.54$ ;  $CI\ 95\%=1.15\ to\ 5.62$ ;  $p=0.020$ ).

This study was in line with the Mota-med et al. (2019), which stated that there was a relationship between smoking habits and the incidence of type 2 diabetes. Someone who smoke was 1.69 times more likely to have type 2 diabetes compared to someone who did not smoke ( $OR = 1.69$ ;  $95\% CI= 1.60\ to\ 1.89$ ;  $p= 0.010$ ). Based on some of the statements above, it can be concluded that smoking affected the incidence of type 2 diabetes.

### **8. The Effect of Village on the Risk of Type 2 DM**

The results showed that there was no contextual effect at the village level on the variation of type 2 DM incident ( $ICC = <0.01\%$ ).

Village is a variable that has an important role in accessing services carried out by the community to the surrounding health facility providers. Based on the Decree of the Minister of Health of the Republic of Indonesia Number 1529/Menkes/SK/X/2010, there are four categories of active alert villages or active alert villages, namely pratama, madya, purnama and mandiri villages. Based on this study, most of the villages that were included in the category of mandiri villages. Villages that are included in the mandiri category already have active health cadres, easy access of the community to basic health services that provide services every day, have active community-based health efforts such as the elderly *posyandu*, *posbindu* and so forth. Therefore, village variables did not affect contextually the variation in type 2 DM incident.

Francisco et al. (2018) reported that demographic areas have no contextual influence on the incidence of type 2 DM ( $OR= 1.21$ ;  $95\% CI\ 95\%= 0.03\ to\ 1.44$ ;  $p= 0.040$ ). This study was in line with Liese et al. (2019), which stated that the distance of access from a residence to a health care provider has nothing to do with the incidence of type 2 diabetes ( $p= 0.110$ ).

This study was consistent with Gassasse et al. (2017), which stated that there was no contextual influence of countries with the incidence of type 2 diabetes. The study was conducted in 207 high and low income countries. Independent variables studied were diet, physical activity and obesity. Type 2 diabetes mellitus caused by diet, physical activity and obesity occurs in high and low income countries. Thus, there was no country contextual effect on the variation in type 2 DM events ( $p = 0.078$ ). Based on the results of this study, it can be concluded that there was a significant influence between family history of DM, diet, physical activity, central obesity, stress, history of hypertension, and smoking habits on the incidence of type 2 diabetes.

### **AUTHOR CONTRIBUTION**

Anggi Putri Aria Gita as the main author has roles to carry out the study, collect the data, formulate the articles, and process the data. Isna Qadrijati played a role in the background and discussion of study. Bhisma Murti played a role in the formulation of the framework and analyzing the data.

### **CONFLICT OF INTEREST**

There was no conflict of interest in this study

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## REFERENCE

- Agrawal V, Kshirsagar A, Patil V (2019). Risk factors of type 2 diabetes mellitus in rural population of Karad, Maharashtra, India: An observational study. *J Adv Med*. 6(5): 1584–1588. <http://doi.org/10.18203/2349-3933.ijam201942-23>.
- Akhtar SN, Dhillon P (2017). Prevalence of diagnosed diabetes and associated risk factors: Evidence from the largescale surveys in. *JOSH-Diabetes*. 5(1): 28–36. <https://doi.org/10.4103/2321-065-6.194001>
- Brayer-Ash M (2012). 100 Tanya jawab mengenai diabetes (100 Questions and answers about diabetes). Jakarta Barat: PT Indeks
- Budiarti E, Tamtomo DG, Adriani RB (2016). Path analysis on the bio-psychosocial determinants of type 2 diabetes mellitus and depression at dr. Moewardi Hospital, Surakarta. *J Epidemiol Public Healt*. 3(1): 1–14. <https://doi.org/10.2-6911/jepublichealth.2018.03.01.01>
- Caballero AE (2018). The “ A to Z ” of managing type 2 diabetes in culturally diverse populations. *Frontiers in Endocrinology*. 9(479): 1-15. Diakses dari [https://www.frontiersin.org/articles-10.3389/fendo.2018.00474/full](https://www.frontiersin.org/articles/10.3389/fendo.2018.00474/full)
- Chandra F, Restuastuti T (2007). Faktor-Faktor risiko pasien diabetes melitus (Risk factors for diabetes mellitus patients). *Jurnal BKM*. 23(3): 142–147. Retrieved from <https://journal.ugm.ac.id/index.php/bkm/article/view/3-621>
- Chireh B, Arcy CD (2019). Shared and unique risk factors for depression and diabetes mellitus in a longitudinal study, implications for prevention: An analysis of a longitudinal population sample aged 45 years. *Ther Adv Endocrinol*. 1(10): 1–15. <https://doi.org/10.1177/20420188-19865828>
- Damayanti S (2015) Diabetes mellitus & penatalaksanaan keperawatan (Diabetes mellitus & nursing management). Yogyakarta: Nuha Medika
- Fearch K, Quist JS, Hulman A, Witte DR, Tabak AG, Brunner EJ, Kivimaki M, et al., (2019). Short Report: Epidemiology prospective association between late evening food consumption and risk of prediabetes and diabetes: the Whitehall II cohort study. *Diabet Med* 1(36): 1256–1260. <https://doi.org/10.1111/d-me.13951>.
- Francisco PMSB, Segri NJ, Borim SFA, Malta DC (2018). Prevalence of concomitant hypertension and diabetes in Brazilian older adults: Individual and contextual inequalities. *Cien Saude Colet*. 23(11): 3829-3840. <https://doi.org/10.1590/1413-8123201-82311.29662016>
- Gassasse Z, Dianna S, Sarah F, Valentina G (2017) Association between urbanisation and type 2 diabetes: An ecological study. *BMJ Glob Health*. 3(1): 1–8. <https://doi.org/10.1136/bmjgh-2017-000473>
- Hariawan H, Fathoni A, Purnawati D (2019). Hubungan gaya hidup (pola makan dan aktivitas fisik) dengan kejadian diabetes melitus di rumah sakit umum Provinsi NTB (Relationship between life-style (diet and physical activity) with the incidence of diabetes mellitus in the NTB General Hospital). *Jurnal Keperawatan Terpadu*. ISSN: 2406. Retrieved from <http://jkt.poltekkes-mataram.ac.->

- id/index.php/home/index
- IDF (2015) IDF Diabetes atlas seventh edition 2015. Brussels: IDF
- Kabosu RAS, Adu AA, Hinga IAT (2019). Faktor risiko kejadian diabetes melitus tipe dua di RS Bhayangkara Kota Kupang (Risk factors for type 2 diabetes mellitus at Bhayangkara Hospital, Kupang City). 1(1) : 11–23. Retrieved from <http://juke.kedok-teran.unila.ac.id/index.php/majority/article/view/1073/-912>
- Liese AD, Xiaonan M, Lauren R, Melanie S, Bethany AB, Jan ME, Janice CP, et al. (2019). Health care access and glycemic control in youth and young adults with type 1 and type 2 diabetes in South Carolina. *Diabet Med*, 1(4): 12-18. <https://doi.org/10.1111/pedi.1282207-11-5>
- Maharana L, Reddy SK, Pattnaik S, Ahmed S, Teja D, HargaviBM, Hussain SS, Sethi MK(2019). A prospective observational study on cardiovascular risk assessment in type-2 diabetes mellitus patients. *J Appl Pharm Sci*, 9(4): 126–132. <https://doi.org/10.7324/JAPS.2019.-90416>
- Ministry of Health (2018). Hasil riset kesehatan dasar republik indonesia tahun 2018 (The results of the Republic of Indonesia's basic health research in 2018). Jakarta: Badan Penelitian dan Pengembangan Republik Indonesia
- Motamed S, Mazidi M, Safarian M, Ghayour-Mobarhan M, Moohebbati M, Ebrahimi M, et al., (2019) Macro-nutrient intake and physical activity levels in individuals with and without metabolic syndrome: An observational study in an urban population Abstract Short Communication. *Arya Atheroscler*. 15(3): 136–145. <http://doi.org//10.22122/arya.v15i3.1303>
- Murad MA, Samia S, Abdulmageed, Iftikhar R, Sagga BK (2014) Assessment of the common risk factors associated with type 2 diabetes mellitus in Jeddah. *J Endocrinol* 5(9): 1-9. <http://doi.org-/10.1155/2014/616145>
- Ogihara T, Mita T, Osonoi Y, Osonoi T, Saito M, Tamasawa A, Nakayama S, et al., (2017). Relationships between life-style patterns and cardio-renal-meta-bolic parameters in patients with type 2 diabetes mellitus: A cross-sectional study. *Plos One*. 3(8): 1–16. <https//doi.org/10.1371/journal.pone.0173540>
- Pratiwi TA, Lubis R, Mutiara E (2018). Pengaruh obesitas terhadap kejadian diabetes mellitus pada wanita usia subur di RSUD dr. Djoelham Binjai tahun 2017 (The effect of obesity on the incidence of diabetes mellitus in women of reproductive age at dr. Djoelham Hospital, Binjai in 2017). *IJHTM*. 4(1): 1–10. Retrieved from [jurnal.uui.ac.id/index.php/JHTM/article/download/161/15](http://jurnal.uui.ac.id/index.php/JHTM/article/download/161/15)
- Priyambodo AD, Wuryaningsih SHP (2017) Karakteristik klien diabetes mellitus di puskesmas pucang sewu surabaya (Characteristics of diabetes mellitus clients in Pucang Sewu Health Center, Surabaya). *JKI*. 10(3): 107-115. Retrieved from <http://journal.poltekkes-depkes-sby.ac.id/index.php/KEP/article/view/952>
- Rahman F, McEvoy JW, Ohkuma T, Marre M, Hamet P, Harrap S, Mancina G, Rodgers A, Selvin E, Williams B, Muntner P, Chalmers J, Woodward M (2019). Diabetes and blood pressure: The ADVANCE trial effects of blood pressure lowering on clinical outcomes according to baseline blood pressure and cardiovascular risk in patients with type 2 diabetes mellitus. *Hypertension*. 1(73): 1291–1299. <https://doi.org/10.1161/HYPERTENSIONAHA.118.12414>
- Sadiya A, Mnla R (2019). Impact of food pat-

- tern on glycemic control among type 2 diabetic patients: A cross-sectional study in the United Arab Emirates. *Diabetes, Metabolic Syndrome, and Obesity: Targets and Therapy*. 1(12): 1143–1150. <https://doi.org/10.2147/DMSO.S209320>
- Shen L, Ao L, Xu H, Shi J, You D, Yu X, Xu W, Sun J, Wang F (2019). Poor short-term glycemic control in patients with type 2 diabetes impairs the intestinal mucosal barrier: A prospective, single-center, observational study. *BMC Endocrin Disorder*. 19(29): 1–6. <https://doi.org/10.1186/s12902-019-0354-7>
- Sukmaningsih WR (2016). Faktor risiko kejadian diabetes melitus tipe II di Wilayah Kerja Puskesmas Purwodiningratan Surakarta (Risk factors for the occurrence of type II diabetes mellitus in Purwodiningratan Health Care, Surakarta). *Publikasi Ilmiah Jurusan Kesehatan Masyarakat Fakultas Ilmu Kesehatan Universitas Muhammadiyah Surakarta*. Retrieved from <https://eprint.ums.ac.id> (25 June 2018)
- Surakarta Health Office (2018). *Profil Kesehatan Kota Surakarta Tahun 2018* (Surakarta City Health Profile in 2018). Surakarta: Dinas Kesehatan Kota Surakarta.
- Tchernof A, Després J (2013). Patho-physiology of human visceral obesity: An update aspects of regional body fat distribution. *Am J Physiol*. 93(1): 359–404. <https://doi.org/10.1152/physre-v.000-33.2011>
- Tjekyan RMS (2014). Angka kejadian dan faktor risiko diabetes melitus tipe 2 di 78 RT Kotamadya Palembang tahun 2010 (Incidence and risk factors for type 2 diabetes mellitus in 78 RT in Municipality of Palembang in 2010). *MKS*. 46(2): 85–94. Retrieved from <https://ejournal.unsri.ac.id/ind-ex.php/mks/article/view/2688/pdf>